PROCESS FOR THE PRODUCTION OF A MULTIDIRECTIONAL TEXTILE PREFORM AND PIECE OF COMPOSITE MATERIAL INCORPORATING SAID PREFORM

The present invention relates to a process for the production of a multidirectional textile preform, more particularly adapted to a piece of composite material used particularly in the aeronautics and space fields.

This type of preform, made from interlaced fibers or filaments, in particular mineral, is embedded in a resin, ceramic, carbon, metallic or other matrix.

Processes and machines for the production of such a preform are described in the documents FR 2718757, FR 2718758 and EP0 284 497.

According to these techniques, the preform is obtained by superposition on a mold, support or mandrel of layers of filaments crossed in at least two directions, said layers being then bonded to each other by means of filaments which pass through them in another direction substantially perpendicular to said layers.

The layers are obtained by deposition of rectilinear sections of filament forming part of a continuous filament, by stretching each filament section between two points of securement. According to a first embodiment, the securement points are obtained by punching the filament at each end of the section into the support. According to another embodiment, the punches or needles are implanted on the support at the ends of the sections, the filament unwinding between said punches so as to obtain rectilinear sections of filament between these latter. The use of punches becomes necessary particularly for the production of layers on a cone with a large summit angle, to hold the

wound filaments and avoid slipping of these latter toward the end of the cone.

The present invention envisages particularly the processes using punches.

The pieces containing this type of preform are particularly used as heat shields for space engines and subjected to very great thermal and mechanical stresses.

The mechanical, thermal and electrical properties of these pieces are connected to the homogeneous character of the proportion of fibers at all points in the preform. Thus, if the proportion of fibers in the preform varies, the mechanical, thermal or electrical properties are altered.

Moreover, the variation in the proportion of fibers is adapted to give rise to densification and possible wear and thus to generate defects contributing to decreasing the characteristics of the piece.

Also, the present invention seeks to improve the prior art techniques by providing a new process for production of a multidirectional textile preform permitting obtaining a more homogeneous proportion of fibers, which contributes to improving the characteristics, particularly mechanical and thermal, of the piece obtained from said preform.

To this end, the invention has for its object a process for the production of a textile preform from interlaced filaments or sections of filament, using a support of a shape suitable to the preform, to which are applied superposed layers of filaments or sections of filaments crossed in at least two directions, said layers being interconnected by means of filaments or sections of filaments which pass through them, and said filaments or sections being stretched or held on said support by pins,

characterized in that it comprises a step of reimplantation of the pins by offsetting them, so as to avoid the concentration of defects inherent in the use of pins.

Preferably, the pins are offset approximately in the direction of the filaments to limit the concentration of the defect induced by inclination of the pins, and/or offset approximately in a direction perpendicular to the filaments to reduce the concentration of the defect appearing between the pins between which are stretched the filaments or sections of filament.

For preforms of cylindrical, conical or truncated conical shape, the number of pins is increased during the reimplantation phase so as to increase the number of filaments or of sections dispose in the longitudinal direction.

To produce a preform comprising a conical or truncated conical portion, the filaments are disposed at the level of the conical or truncated conical portion, by angular sector, so as to form chevrons, these latter coming to an end as the radius decreases, so as to obtain a constant proportion of filaments. To avoid the concentration of the defects inherent in the use of pins, these latter used for the production of chevrons are reimplanted at least once, by offsetting them longitudinally and angularly.

Preferably, the number of chevrons per angular sector is increased during reimplantation.

The invention also has for its object a piece of composite material comprising a textile preform produced according to the invention, embedded in a matrix of resin, ceramic, carbon, metal or the like.

Other characteristics and advantages will become apparent from the description which follows, of the

invention, which description is given solely by way of example, with respect to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of an example of textile preform comprising a cylindrical portion prolonged by a conical portion.

Figure 2 is a cross-sectional view of the support or mandrel used to obtain the preform of Figure 1.

Figure 3A is a perspective view showing the step of weaving.

Figure 3B is a perspective view showing the step of winding.

Figure 3C is a transverse cross-sectional view showing the step of stitching; and

Figure 4 is a detail view showing the production of chevrons during the step of weaving on the conical portion.

In Figure 1, there is shown an example of multidirectional textile preform 10 obtained according to the process of the invention.

This type of preform, made from interlaced filaments or fibers 12, in particular mineral, is embedded in a matrix of resin, ceramic, carbon, metal or the like, so as to obtain a piece of composite material used particularly in the fields of aeronautics and space.

According to the selected embodiment, the preform 10 has a cylindrical portion 14 prolonged by a conical portion 15. Of course, the invention is not limited to this shape and comprises any other volumetric shape.

For the production of the preform, there is used a support for stitching a device 16 on the surface of which can be implanted pins 18.

This support 16 has a profile suitable for the shape of the preform 10. According to the selected example, there is used a so-called mandrel support 16, shown in Figure 2, whose external shape corresponds to the internal shape of the preform.

This support is of suitable material permitting the implantation of the pins 18 and holding them.

According to the example, the textile preform 10 is obtained from interlaced fibers or filaments, disposed in at least two directions, preferably three directions which are preferably orthogonal.

In Figures 3A to 3C, there is shown the different steps of the deposition of the filaments, Figure 3A showing the weaving phase corresponding to the deposition of filaments in the longitudinal direction, Figure 3B showing the winding phase corresponding to the deposition of filaments in the circumferential direction and Figure 3C showing the stitching phase, the filaments being disposed in the radial direction.

In what follows of the description, there will be used interchangeably the terms "filament" or "fiber" and the terms "layer" or "stratum" to designate the assembly obtained by an operation of weaving and winding.

The pins 18 are necessary as points of securement between which are stretched the sections of filament during the weaving phase, to ensure holding the filaments during the winding phase, particularly when the cone angle is very wide and finally to produce the conical portion as will be explained later.

To obtain optimum mechanical, thermal and electrical characteristics, it is important to arrive at a volumetric proportion of filaments corresponding to the ratio between

the intrinsic volume of the filaments and the volume homogeneously occupied by the filaments.

However, the use of pins 18 gives rise systematically to defects.

On the one hand, because of the inclination of the pins during winding, there remains a circumferential region without filaments located on the side to which the pin is inclined.

On the other hand, the use of pins gives rise during weaving to a region having a low proportion of filaments at the level of the generatrices bearing the pins.

Finally, the production of a circular, conical or truncated conical shape by superposition of successive layers produces at the level of the external radii, a proportion of winding filaments that is relatively low.

To remedy the concentration of these defects, the process for production of a multidirectional textile preform according to the invention comprises a step of reimplantation of the pins, by offsetting them.

Thus, the defects are distributed over all of the volume, which permits obtaining a piece with a proportion of filaments that is more homogeneous and a lesser variation.

For better distribution, during reimplantation, the pins are offset in the longitudinal direction so as to reduce the defect induced by the inclination of the pins and/or in the circumferential direction so as to reduce the defect generated at the level of the generatrices.

Moreover, to compensate the reduction of the proportion of weaving filaments for large radii, there is increased during reimplantation the number of pins so as to increase the number of filaments stretched during weaving

phase so as to obtain a more constant proportion of filaments across the thickness of the preform.

Even if it could be considered that numerous reimplantations would permit obtaining a better distribution of the defects, it will be noted that in practice that one to two reimplantations suffices for a total number of about 40 layers to obtain a satisfactory distribution of the defects and a substantially constant proportion of filaments throughout the volume of the preform.

The reimplantation or each reimplantation is carried out after the production of a certain number of layers, which can be variable.

At the level of conical portion 15, the filaments 12 are deposited during the step of weaving per angular sector so as to form chevrons 20, as shown in Figure 4. The chevrons 20 stop progressively as the radius decreases so as to obtain a constant proportion of filaments.

The stopping position of the chevrons is determined as a function of the shape, which can be conical or not, of the number of layers already produced, preferably by a dichotomy method, so as to obtain a proportion of weaving filaments as constant as possible.

To distribute the defects, as above, recourse is had to at least one reimplantation by longitudinally and angularly offsetting the pins necessary for the production of the chevrons 20.

Moreover, to compensate the drop in proportion of filaments produced by increase of diameter, there is increased the number of chevrons per sector during reimplantation.

In practice, the pins can be disposed directly on the mandrel or support 16 or connected to guidance crowns disposed at one end of the mandrel or at its two ends. The reimplantation of the pins takes place preferably on the mandrel, the pins being reimplanted into the preform already produced, which gives to them better rigidity.

Of course, the invention is clearly not limited to the embodiment described and shown above, but on the contrary covers all variations, particularly as to the shape of the textile preform to be produced and the nature of the filaments and of the matrix.